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CONSTRUCTION OF SMALL HYDROELECTRIC POWER PLANTS IN YUGOSLAVIA

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The following report was given at the conference of engineers and technicians for the mechanization and electrification of agriculture, held in Novi Sad, May 1950.

Yugoslavia offers excellent natural conditions for the construction of small hydroelectric power plants of up to 15 horsepower, as proved by the tens of thousands of water mills on Yugoslav rivers and streams. In most cases, full utilization is not made of these small streams, so construction of power plants could be started immediately on these streams. This is not the case, however, with the construction of over-15-horsepower plants, which almost always must be planned in accordance with the proper economic utilization of the water.

The turbines and the entire installation of a small power plant may be rather rudimentary with a limited degree of effectiveness. The method of regulating [the flow of water at] a small plant may be elementary, if there is any regulation at all, while the larger plants require automatic regulation devices. While the utilization (or partial utilization) of direct-current generators for small power plants may be considered, the larger power plants unquestionably require three-phase current, and direct current is considered for them only in exceptional cases.

Therefore, it is easier to begin mass construction of small power plants. Elementary types of construction for these power plants may be entrusted to locally available technical personnel, and use can be made of construction materials available locally. Wood construction can be used for turbines as well as for all the other installations of small power plants.

In the postwar years, several attempts were made to partially solve the problem of constructing small power plants. These attempts usually failed or were very modestly successful.

Systematic work on the mass production of small hydroelectric power plants requires a survey of the need for power in the area, and a survey of water power available in the area. The extent to which local industries are able to participate in constructing installations should be taken into consideration.

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In this regard, work already completed in the field of standardization on the initiative of electric power or waterpower agencies or their experts and some other agencies was taken into consideration; such as the model of a 6.5-horsepower hydroelectric power plant, planned by Professor Obradovic. The basic idea was to build the entire plant out of wood, except for a few parts, so that the work could be done by local carpenters and wheelwrights. The projected turbine was the most simple nonregulating type, which would present no difficulties for mass production.

Some other proposals for standardizing small power plants were made by Engineer-Doctor Slebinger and the Administration for the Development of Production in Ljubljana. The latter suggested standardizing 10- to 150-horsepower power plants. The standardization consists in constructing two turbines, with rotors 450 and 600 millimeters in diameter, respectively. The rotor blades (made like a four-bladed propeller turbine) are fastened to the rotor head with various gradients for various conditions. The transmission of potential energy from the vertical axle of the turbine to the horizontal axle of the generator is done with conical gears. The generator makes 1,000 revolutions a minute, is the synchronized type, has a capacity of 400-420 volts or 3,000 volts, and is equipped with a manual regulator. Other equipment is standard.

Small power plants of up to 15 horsepower also can be built as floating installations. Since Yugoslavia has many rivers in flat areas, at least a part of their unexploited power could be utilized in this way.

The turbine installation may consist of a water wheel or propeller. Because of the slow flow of the streams, however, only rather small propellers may be considered (e.g. a propeller 1.5 meters in diameter would produce 4-5 horsepower with a stream flow of 2 meters a second). If a water wheel is used, it should be large because of the small number of revolutions it makes. Consequently, a propeller would be more suitable, because the degree of effectiveness of the installation decreases as the number of revolutions increases.

The floating installation may be a boat, barge, pontoon, or a raft, which can be made very simply with four buoys and a floor of wooden planking or iron beams. Since the power output of such a plant would be relatively small, the simplest and least expensive type of construction should be used. The propeller may be either set up in the water by itself or mounted in a cone-shaped pipe with spiral action. Rotating power from the propeller axle to the generator axle can be transmitted by a chain or in some other way. The propeller may be wood, sheet metal, or aluminum. One floating installation may carry one or more such power units.

Systematic work on establishing the needs and potentialities for electric power has not been done anywhere in Yugoslavia. Some incomplete surveys of localities and power plants where construction work was to be started immediately, were forwarded by the Administration for the Development of Production in Bosnia and Herzegovina, Macedonia and Montenegro.

According to these surveys, Bosnia and Herzegovina should construct: thirty 5-horsepower, fifty 10-horsepower, twenty 15-horsepower, twenty-five 20-horsepower, four 30-horsepower, four 50 horsepower hydroelectric power plants, and one of 100-horsepower capacity.

The Administration for the Development of Production in Macedonia reported that the following could be constructed in Macedonia: two 15-horsepower, ten 22-horsepower, eighteen 27-horsepower, twenty-six 33-horsepower, thirty-two 50-horsepower, six 57-horsepower, seven 75-horsepower, and seven 125-horsepower hydroelectric power plants and one of 200-horsepower capacity.

The Administration for the Development of Production in Montenegro reported that the following could be constructed in Montenegro: four 50-horsepower and seven 400-horsepower hydroelectric power plants.

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Since Macedonia alone has 8,700 water mills and Yugoslavia has over 30,000. the above data represent only a very small part of the power which could be utilized for the electrification of Yugoslavia. For instance, Slovenia has about 4,000 water mills with a total of 40,000 horsepower. If only 50 percent of these mills were rebuilt with modern turbines, they could produce 60 million kilowatt-hours annually. Because of the branched structure of the electric-power network in Slovenia, asynchronous generators could be utilized which would decrease construction and operation costs considerably.

Except for the republics mentioned above, no other republics have submitted concrete data on their needs for small hydroelectric power plants. Serbia, which has had the most experience in constructing small hydroelectric power plants, is taking energetic action, in cooperation with the Administration for the Development of Production, to solve the problem of constructing small hydroelectric power plants. Certain attempts have been made to work on this problem systematically in Slovenia, but without concrete results. Croatia shows no indication that anything has been done on this problem, nor is a study being made for a complete or partial solution. Croatia has not even achieved the partial results accomplished in the other republics.

Another problem is whether direct current may be used, and if so, when and where. Since Yugoslavia manufactures radios which operate on alternating current only, alternating-current generators are more satisfactory than direct-current generators. On the other hand, especially at the small power plants with regulators, direct current would be better.

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